

Listing of Claims

1. (Previously presented) A control valve arrangement for use in controlling fuel pressure within a control chamber of a fuel injector thereby to control the movement of an injector valve needle relative to an injector valve seating wherein, in use, a portion of the injector valve needle is exposed to fuel pressure within the control chamber, the control valve arrangement including:

a control valve member that is movable between a first position and a second position,

wherein, in the first position, the control valve member engages a first seating such that the control chamber communicates with a source of high pressure fuel and communication between the control chamber and a low pressure fuel drain is prevented thereby urging the injector valve needle against the injector valve needle seating, and

wherein in the second position the control valve member engages a second seating such that the control chamber communicates with the low pressure fuel drain and communication between the control chamber and the source of high pressure fuel is broken thereby causing the injector valve needle to lift away from the injector valve needle seating,

wherein the second seating is defined by a surface of a bore provided in a valve housing within which the control valve member is movable; and

a restricted flow path for:

i) restricting the rate of flow of fuel from the control chamber to the low pressure fuel drain when the control valve member is moved from the first position to the second position, thereby reducing the speed at which the injector valve needle lifts from the injector valve needle seating; and

ii) restricting the rate of fuel flow from the source of high pressure fuel to the low pressure fuel drain when the control valve member is moved from the second position to the first position to urge the injector valve needle against the injector valve needle seating while reducing the loss of high pressure fuel to low pressure,

wherein the restricted flow path comprises a restricted flow passage being located between the first seating and the second seating and defined by an outer surface of the control valve member and the bore in the valve housing.

2. (Cancelled)

3. (Previously presented) A control valve arrangement as claimed in Claim 1, wherein the restricted flow path is arranged so that fuel flow rate out of the control chamber to the low pressure drain is relatively low whereas the fuel flow rate into the control chamber is relatively high, thereby providing asymmetric control valve operation.

4. (Cancelled)

5. (Previously presented) A control valve arrangement as claimed in Claim 1, wherein the control valve member is movable within the bore provided in the valve housing and wherein an insert is arranged within the bore in the valve housing to define the first seating.

6. (Cancelled)

7. (Cancelled)

8. (Withdrawn) A control valve arrangement as claimed in Claim 1, wherein the control valve member is shaped such that the restricted flow passage is defined, in part, by a control flat provided on the outer surface of the control valve member.

9. (Cancelled)

10. (Previously presented) A control valve arrangement as claimed in Claim 1, wherein the restricted flow path is arranged upstream of the first seating and downstream of the second seating.

11. (Withdrawn) A control valve arrangement as claimed in Claim 1, wherein the restricted flow path is arranged downstream of the first seating, between the first seating and the low pressure drain.

12. (Previously presented) A control valve arrangement as claimed in Claim 1, wherein the restricted flow path is defined by an orifice provided in the control valve member.

13. (Withdrawn) A control valve arrangement as claimed in Claim 1, wherein the control valve arrangement includes a by pass flow path arranged within the control chamber (30).

14. (Withdrawn) A control valve arrangement as claimed in Claim 13, wherein the by pass flow path is provided with a plate valve arrangement including a plate valve member provided with a control orifice extending therethrough.

15. (Withdrawn) A control valve arrangement as claimed in Claim 14, wherein a wall of the control chamber defines a plate valve seating, whereby the plate valve member is moveable against the plate valve seating by means of fuel pressure within the control chamber, so as to ensure the flow of fuel from the control chamber passes through the control orifice when the plate valve member is engaged with the plate valve seating.

16. (Withdrawn) A control valve arrangement as claimed in Claim 15, wherein the control chamber is shaped to define a by pass flow passage around the plate valve member, whereby a substantially unrestricted flow of fuel can enter the control chamber when the plate valve member is urged away from the plate valve seating.

17. (Previously presented) A fuel injector for use in delivering fuel to an internal combustion engine, the fuel injector comprising:

a valve needle that is engageable with a valve needle seating, in use, to control fuel delivery through an outlet opening,

a surface associated with the valve needle being exposed to fuel pressure within a control chamber, and

a control valve arrangement for controlling fuel pressure within the control chamber, the valve arrangement including:

a control valve member that is movable between a first position to engage a first seating in which the control chamber communicates with a source of high pressure fuel and communication between the control chamber and a low pressure fuel drain is prevented thereby urging the injector valve needle against the injector valve needle seating, and a second position to engage a second seating in which the control chamber communicates with a low pressure fuel drain, and communication between the control chamber and the source of high pressure fuel is broken, thereby causing the injector valve needle to lift away from the injector valve needle seating, wherein the second seating is defined by a surface of a bore provided in a valve housing within which the control valve member is movable; and

a restricted flow path for restricting the rate of flow of fuel from the control chamber to the low pressure fuel drain when the control valve member is moved from the first position to the second position, thereby reducing the speed at which the injector valve needle lifts from the injector valve needle seating and restricting the rate of fuel flow from the source of high pressure fuel to the low pressure fuel drain when the control valve member is moved from the second position to the first position to urge the injector valve needle against the injector valve needle seating while reducing the loss of high pressure fuel to low pressure,

wherein the restricted flow path comprises a restricted flow passage being located between the first seating and the second seating and defined by an outer surface of the control valve member and the bore in the valve housing.

18. (Cancelled)

19. (Previously presented) A fuel injection system for an internal combustion engine comprising a fuel injector for use in delivering fuel to an internal combustion engine, the fuel injector comprising a valve needle that is engageable with a valve needle seating, in use, to control fuel delivery through an outlet opening, a surface associated with the valve needle being exposed to fuel pressure within a control chamber, and a control valve arrangement as claimed in Claim 1 for controlling fuel pressure within the control chamber.